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CASE REPORTS

Complications Associated With the Guide Wire in Percutaneous Transluminal Coronary Angioplasty

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This report describes three cases of unraveling of the platinum coil of the guide wire during percutaneous transluminal coronary angioplasty. In one case the wire ruptured and required surgical removal. The exact cause of this phenomenon is not known, but wire entrapment may be a factor. This is more likely to occur with tortuous vessels. Precautions to avoid uncoiling and rupture of guide wires during coronary angioplasty are discussed.

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Percutaneous transluminal coronary angioplasty is widely used in the treatment of patients with coronary artery disease. The introduction of the steerable guide wire in 1982 improved the primary success rate from 59% (1) to 91% (2) and decreased the incidence of serious intraprocedure complications from 9.2% (3) to 4.1% (2). However, the guide wire itself is not without hazard. For example, one case of perforation of a coronary artery, probably by the guide wire, has been reported (4), and in larger reports of coronary dissection during angioplasty, the role of the guide wire as a possible precipitator of dissection has not been ruled out.

This report presents three cases of complications due to uncoiling of the distal end of the USCI Flexible Steerable 0.014 inch (0.035 cm) J guide wire. In two cases the guide wire was removed intact and without sequelae, but in the third case the wire broke in situ leaving a fragment within the coronary vasculature that had to be removed surgically.

Case Reports

Case 1

A 70 year old man presented with recurrent episodes of acute coronary insufficiency resulting in pulmonary edema requiring intubation and ventilation in the intensive care unit. Coronary angiography revealed a subtotally occluded left anterior descending artery just beyond the origin of the first diagonal branch and a high grade stenosis in a large third obtuse marginal branch of the circumflex artery. Because of prior lung surgery he was considered to be a poor candidate for coronary artery bypass surgery but anatomically suitable for coronary angioplasty.

At angioplasty, the left anterior descending artery stenosis was crossed with a USCI 0.014 inch flexible J guide wire and successfully dilated with a USCI 2.5 mm balloon. To enter the circumflex artery it was necessary to manually increase the distal angle of the J guide wire. This permitted successful entry into the circumflex artery and its third obtuse marginal branch. The lesion was crossed with the wire and the balloon advanced into the narrowed segment. However, just before balloon inflation, it was noted that there was a translucent segment in the spring coil suggesting a break (Fig. 1). The lesion was successfully dilated and then the balloon catheter and guide wire were simultaneously removed as a unit. Direct inspection showed that the coiled platinum wire on the steel core had become unraveled 2 cm from the tip, thus accounting for the appearance of radiolucency on fluoroscopy.

Case 2

A 68 year old man with prior triple coronary bypass surgery had recurrent angina. Coronary angiography showed patent undiseased left anterior descending and intermediate saphenous vein grafts, but a 60% stenosis at the distal anas-

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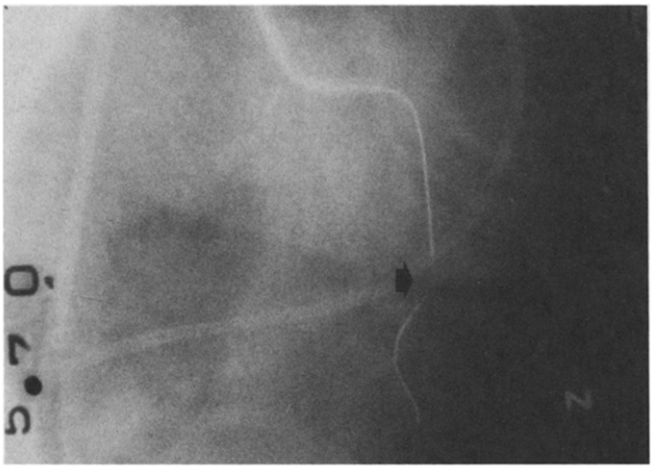

Figure 1. Case 1. Right anterior oblique projection. The guide wire is in the circumflex artery with the tip in a third obtuse marginal branch beyond the stenosis. The **arrow** indicates a segment of translucency in the wire, presumably due to unraveling of the platinum coil.

tomosis of the right bypass graft and an 80% stenosis in the proximal posterior descending branch (Fig. 2A).

At coronary angioplasty, a USCI 0.014 inch flexible J guide wire was easily advanced through the right vein graft and distal anastomotic stenosis but the posterior descending branch could not be entered despite modification of the J tip. At this point the graft stenosis was partially dilated with a USCI 2.5 mm balloon. The balloon was then exchanged for a USCI 3.0 mm low profile balloon and it was then possible to successfully enter the posterior descending artery with the wire and cross the lesion. The tip of the wire entered a small septal branch just distal to the stenosis. At this stage the guiding catheter became wedged and it was gently retracted for a centimeter or so at which point it was noted that the distal tip of the wire remained immobile. Several attempts to withdraw the J wire or to dislodge the tip were unsuccessful. The entire system, that is, guide wire, balloon catheter and guiding catheter, was withdrawn in an attempt to free the end of the wire and, as this was being done, the distal spring coil unraveled as evidenced by the appearance of a distal segment of radiolucency. The wire broke, leaving a segment of unraveled platinum wire within the posterior descending artery and the right bypass graft, with the proximal end in the descending thoracic aorta (Fig. 2B). The patient remained asymptomatic and was hemodynamically stable. He was taken to the operating room where a longitudinal incision was made into the right bypass graft and the wire was secured with a hemostat. The proximal end was easily removed but the distal end required considerable traction to be freed. A new right saphenous graft was constructed to the posterior descending artery and distal right coronary artery.

On direct inspection of the segment of wire that had been removed, it was noted that the distal 3 mm were intact but proximal to this point the single platinum coil had become unraveled (Fig. 2C). It was also observed that the forming ribbon had become detached from the distal tip weld. The end of the forming ribbon and the distal solder joint are shown in Figure 3.

Case 3

A 76 year old woman with a prior resected inferior left ventricular aneurysm and a vein bypass to the second obtuse marginal branch of the circumflex artery was admitted with unstable angina. Coronary angiography disclosed a 60% stenosis in the midportion of the circumflex artery. Because of continuing in-hospital episodes of acute coronary insufficiency that were refractory to pharmacologic therapy, coronary angiography was repeated and showed progression of the lesion to a subtotal occlusion.

At coronary angioplasty, a USCI 2.0 mm balloon and 0.014 inch flexible J guide wire were utilized and guided into the circumflex artery. The wire repeatedly entered a small obtuse marginal branch proximal to the area of subtotal occlusion. After several attempts to pass the stenotic area, it appeared that the tip was immobile and could no longer be steered. Several attempts were made to free the tip of the J wire by gentle retraction, but in so doing the distal radioopacity disappeared suggesting unraveling of the platinum wire coil. The guide catheter was advanced more deeply into the circumflex artery and the entire system—guide wire, balloon catheter and guiding catheter—was withdrawn. The patient's condition suddenly deteriorated and repeat coronary injection showed a total occlusion of the circumflex artery. A very flexible USCI 0.014 inch guide wire was passed across the occlusion and four dilations that successfully opened the circumflex artery were performed. The patient's clinical condition improved dramatically and remained stable.

Discussion

There have been a number of reports (1–5) on complications occurring during percutaneous transluminal coronary angioplasty, but we have not encountered any reports regarding uncoiling or rupture of the guide wires, and had not seen such a phenomenon in over 600 cases performed in our institution before these events.

The guide wires used in our three cases were USCI 0.014 inch flexible steerable J wires (Fig. 3). The total length of the wire is 175 cm long, the distal segment of which is tapered. Wound on this tapered segment is a tightly coiled single strand platinum wire 25 cm in length which makes this segment radioopaque and provides steerability to the system. The final 2 cm extend beyond the central steel core. The platinum coil is soldered to the steel shaft at two points

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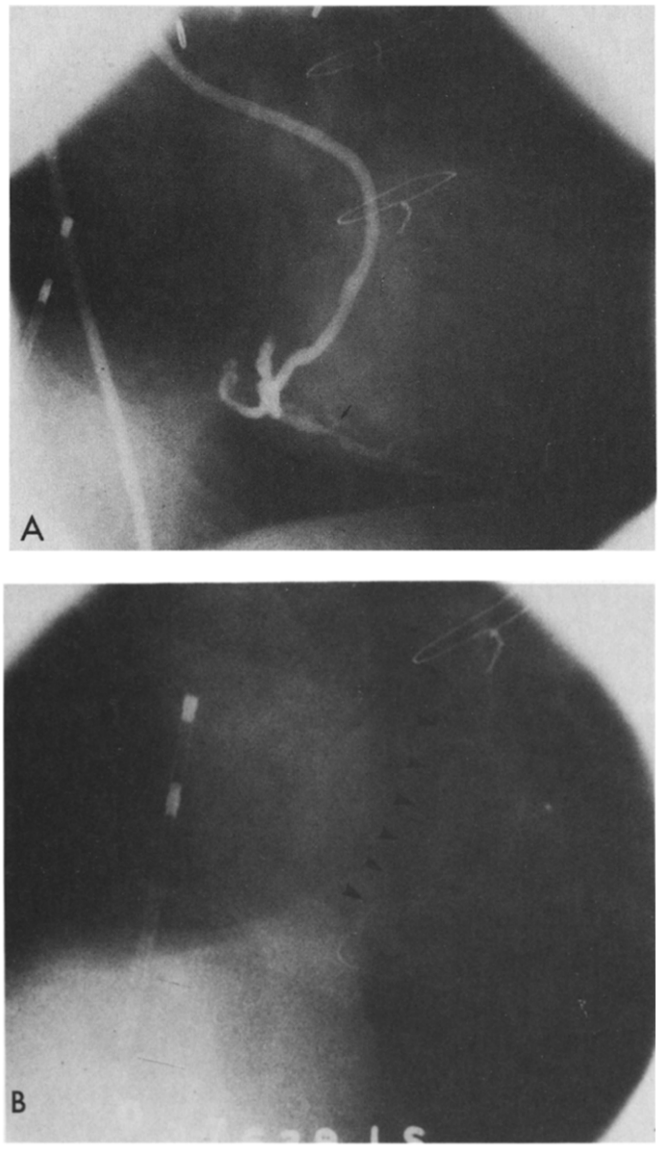


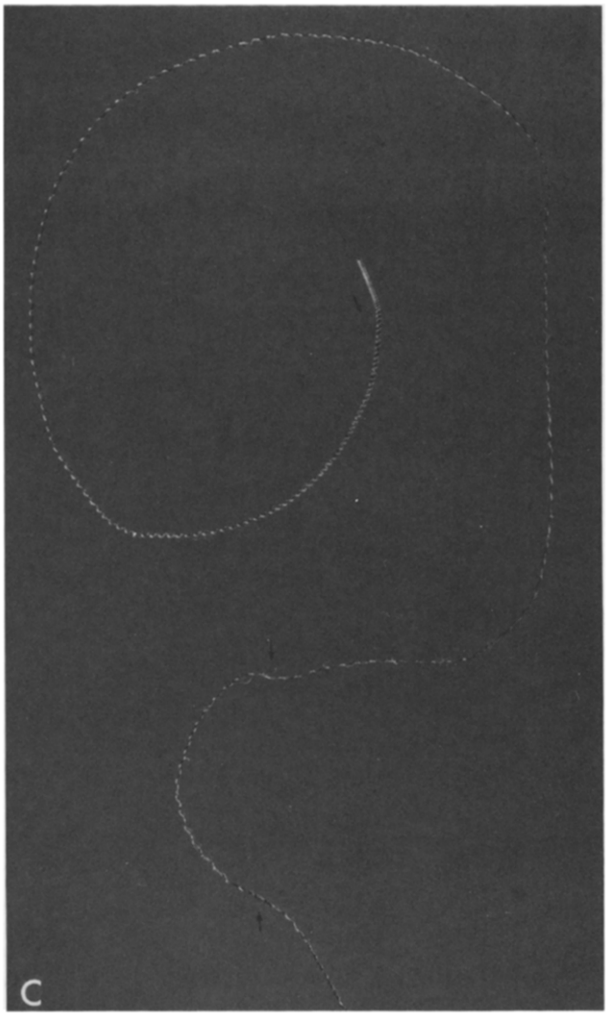


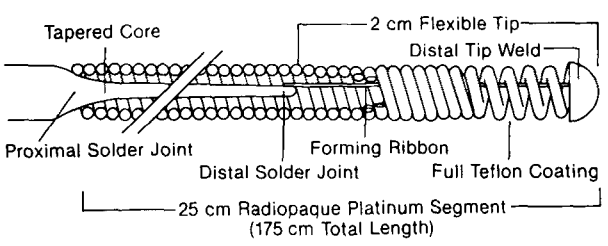
Figure 2. Case 2. **A,** Right anterior oblique projection of an angiogram of the right bypass graft and the ongoing right coronary artery showing a significant stenosis **(arrow)** in the posterior descending branch. **B,** A wire fragment is lodged in the posterior descending branch and the bypass graft. The distal segment has not unraveled and therefore is more radiopaque **(arrows). C,** The segment of wire removed surgically. The **arrow** on the top shows the point at which the unraveling of the wire began. The forming ribbon is detached from the tip **(middle arrow).** The **arrow** at the bottom of the picture shows the distal solder joint.

at its proximal end called the proximal solder joint, and at three points more distally called the distal solder joint. A forming ribbon extends from the distal solder joint to the distal tip weld. The wire is coated throughout its length with Teflon.

The J curve at the tip allows the catheter to be directed into the correct coronary artery or its branches by rotating it either in a clockwise or counterclockwise manner while advancing the dilating catheter. This rotation should never exceed 180°. In certain situations, the 30° terminal angulation of the J tip is insufficient and gentle manual bending of the tip to increase its angle is necessary to negotiate acute turns.

Unraveling rupture of the platinum coil: wire entrapment. We suspect that in our three cases immobilization of the distal tip of the wire played an important role in the unraveling of the platinum coil, and in one case its

Figure 3. The structure of the 0.014 inch flexible J guide wire used in the three cases (modified from USCI specifications).



rupture. The two factors that contributed to this phenomenon in our cases were entrapment of the wire in a small branch that occurred in two and vessel tortuosity, which was present in all three. Overrotation of the wire beyond 180° in either direction, particularly if the tip is not free, is a well known cause of coil unraveling. Although we cannot totally exclude overrotation as a contributing factor in these cases, it is our practice to consciously avoid this. Also, we have taken a 0.014 inch wire, held one end immobile and pulled the other end without prior rotation; the wire uncoiled and then broke and had the appearance of the wire in Case 2, except that the rupture point in this in vitro test was at the proximal solder point rather than in the platinum coil itself. This suggests that wire entrapment alone can lead to wire rupture; if attempts are made to withdraw it, the platinum segment not only unravels but also stretches, weakens and may break.

It is unlikely that reshaping of the tip was a major initiating factor. This has been commonly used in other situations where an angle greater than 30° was required. In fact, in all three cases, it appeared on fluoroscopy that the coil unraveled proximal to this point of angulation.

Manufacturing defects? Intrinsic manufacturing defects of the wire cannot be totally excluded. Cases 2 and 3 occurred consecutively and came from the same batch of wires. However, in Case 2, microphotography showed that the proximal soldering point was intact, and this would be the most likely location of breakage from a structural error. A decrease in the strength of the platinum due to a change in manufacturing is a possibility but likely would have lead to other reports of wire complications, and this did not occur.

Errors in technique? Finally, we believe that errors in technique or operator inexperience did not play a role in any of the three cases. The standard procedure of Gruentzig was followed conscientiously. At the time of these events, the operator in Cases 1 and 2 had performed 235 cases and the operator in Case 3, 179 cases. Both operators had used USCI equipment, including the 0.014 inch flexible J wire, almost exclusively.

Conclusion. We believe that wire tip entrapment was a major factor and possibly the only factor in the uncoiling process that occurred in these cases. Diminished or absent steerability may herald entrapment. If this is noted, particularly if the wire tip is in a side branch, it should be gingerly withdrawn. If this cannot be done or the wire begins to uncoil as evidenced by the appearance of a segment of radiolucency, then if possible the guiding catheter should be deep seated in the coronary artery to strengthen the fulcrum. It may then be possible to withdraw the wire and dilating catheter without further unraveling. It is also important to reemphasize that overrotation of the wire is always inadvisable but is particularly hazardous with tip entrapment. Special care should be taken with tortuous vessels and distal lesions in which loss of steerability and wire entrapment are more likely to occur.

We thank L. Mickleborough, MD, FRCSC, the surgeon in Case 2.

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